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BE BOUNDLESS

BENGALURU CITY UNIVERSITY

SYLLABUS For B.Sc. CHEMISTRY
(I to VI Semester)

CHOICE BASED CREDIT SYSTEM

2020-2021

Proceedings of the meeting of the Board of Studies in Chemistry (UG) held on 20th March 2020 in the Department of Chemistry, Central College Campus, Bengaluru Central University, Bangalore – 560 001

A meeting of the Board of Studies in Chemistry (UG) was held on Friday, 20th March 2020 at 10.30. AM in the Department of Chemistry. The Chairman welcomed the members and placed before them the following agenda.

1. **Approval of B.Sc. Chemistry syllabus for the year 2020-21 batch onwards**

The committee members have gone through the syllabus of all the Six semesters and made several corrections in both theory as well as practicals and approved the syllabus.

The meeting ended with vote of thanks by the Chairman, Dept. of Chemistry, Bengaluru Central University, Central College Campus, Bangalore 560 001.

MEMBERS OF THE BOS (UG)		**Signature**
01. Prof. M. Pandurangappa	Chairman	20/03/2020
02. Prof. S. Hariprasad (co-opted)	Member	20/3/2020
03. Prof. V. R. Devaraju (co-opted)	Member	Absent
04. Dr. Shashikala Devi. K	Member	20/3/2020
05. Prof. Shamsiya Rizwana	Member	
06. Prof. Lalitha Masti Gowda	Member	

07. Prof. Udaya Kumar. S	Member	
08. Prof. B. Vijaya Babu	Member	
09. Dr. Nanda. N	Member	20/3/2020
10. Prof. L. Jayakumar	Member	20/3/2020
11. Dr. B.P. Dayananda	Member (External)	20/3/2020
12. Dr. Bibi Ahamadi Khatoon	Member (External)	20/3/2020

Dr. M. PANDURANGAPPA
Professor and Chairman
Department of Studies in Chemistry
Bengaluru Central University
Central College Campus,
BENGALURU - 560 001

BENGALURU CENTRAL UNIVERSITY.BENGALURU.

SCHEME OF EXAMINATION.

Title of the paper	Contact hours/Week	Exam. hours	IA	Marks	Total Marks	Credits
First Semester						
Chemistry-I	4	3	30	70	100	2
Chemistry Practical-I	3	3	15	35	50	1
Second Semester						
Chemistry-II	4	3	30	70	100	2
Chemistry Practical-II	3	3	15	35	50	1
Third Semester						
Chemistry-III	4	3	30	70	100	2
Chemistry Practical-III	3	3	15	35	50	1
Fourth Semester						
Chemistry-IV	4	3	30	70	100	2
Chemistry Practical-IV	3	3	15	35	50	1
Fifth Semester						
Chemistry-V	3	3	30	70	100	2
Chemistry Practical-V	3	3	15	35	50	1
Chemistry-VI	3	3	30	70	100	2
Chemistry Practical-VI	3	3	15	35	50	1
Sixth Semester						
Chemistry-VII	3	3	30	70	100	2
Chemistry Practical-VII	3	3	15	35	50	1
Chemistry-VIII	3	3	30	70	100	2
Chemistry Practical-	3	3	15	35	50	1

VIII						

B.Sc., - I Semester

Paper I –

SECTION – A **26 hrs**

Atomic Structure	**:**	**13 hrs**
Chemical Bonding and Molecular Structure	**:**	**13hrs**

1. Atomic Structure 13 hrs

Atomic Structure: Bohr's theory and its limitations, dual behavior of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it.Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance.Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s. Shapes ofs, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (m_s).Rules for filling electrons in various orbitals, Electronic configurations of the atoms.Stability of half-filled and completely filled orbitals, concept of exchange energy.Relative energies of atomic orbitals, Anomalous electronic configurations.

2. Chemical Bonding and Molecular Structure 13 hrs

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds.Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability.Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combinationof orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+. Comparison of VB and MO(approach)

Metallic bonding and semiconductors

SECTION – B 26hrs

Fundamentals of Organic Chemistry & Stereochemistry : 8hrs
Aliphatic Hydrocarbons : 9hrs
Aromatic hydrocarbons : 9 hrs

Fundamentals of Organic Chemistry 4 hrs

Bond cleavage - homolytic and heterolysis- Explanation with examples. Types of reagents: Electrophilic and nucleophilic reagents-definition and examples. Reactive intermediates - generation ,structure and relative stabilities of carbocation, carbanion, carbon free radicals, carbenes and nitrenes - explanation for relative stability and reactivity based on inductive, resonance and hyperconjugative effects. Types of reactions: addition, substitution and elimination- examples.

Isomerism:StructuralandStereoisomerism4 hrs

Chain, Position, functional, metamerism,tautomerism types explanation with an example.
Conformations with respect to ethane, butane and cyclohexane - energy profile diagrams. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Configuration- Geometrical: conditions, cistrans isomers. Optical isomerism- concept of chirality (upto two carbon atoms).

Aliphatic hydrocarbons 9 hrs

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: Preparation: Corey- House reaction and Wurtz reaction - Comparison.

Reactions: free radical substitution: halogenation.

Alkenes: Preparation of Alkenes- cis alkenes (partial catalytic hydrogenation) and trans alkenes (Birch reduction), Wittig reaction-stereo selectivity to be mentioned. Reactions: cis-addition (alk. $KMnO_4$)and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition)- mechanism, hydration, ozonolysis-significance, oxymercuration-demercuration,hydroboration-oxidation.

Dienes: Classification- isolated, conjugated, cumulated-one example. Structure of allene and butadiene. Reactions: i)1, 2-addition and 1, 4 addition reactions. ii)Diels Alder reaction: 1, 3-butadiene with maleic anhydride as an example.

Alkynes: Preparations–from vicinal and germinal halides

Reactions-Acidic nature of terminal alkynes: reaction with ammoniacal solutions of silver nitrate and cuprous chloride. Significance – conversion of lower terminal alkynes to higher alkynes. oxidation with $KMnO_4$, ozonolysis.

Aromatic hydrocarbons 9 hrs

Nomenclature: Mono, di and tri substituted benzene, Aromaticity: Criteria for aromaticity and Huckel's rule. Examples: cyclopropenylcation, cyclopentadienylanion, cycloheptatrieneylcation, benzene, naphthalene, anthracene and phenanthrene.

Anti-aromaticity: Features, examples cyclobutadiene,cyclopentadiene.

Non aromatics: examples butadiene, hexa-1,3,5-triene.

Preparation: Chloro,bromoandiodo-benzene:fromphenol,Sandmeyer

Electrophilic substitutions reaction: Nitration of benzene: mechanism, energy profile diagram, evidences for the formation of nitronium ion, kinetic isotopic effect.

Orienting influence of substituents: phenol, toluene, chlorobenzene, nitrobenzene towards electrophilic substitutions

Oxidations: Side chain oxidation of toluene to benzaldehyde and benzoic acid. Alkenyl benzenes: Styrene, preparation uses of styrene, cis and trans-stilbenes-structures and their preparations.

Reference Books:

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. &Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
4. Huheey, J.E., Keiter, E.A., Keiter, R.L. &Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
5. Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
6. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
7. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
8. Eliel, E.L. Stereochemistry of Carbon Compounds, Tata McGraw Hill education, 2000.
9. Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
10. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
11. Bahl, A. &Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
12. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).

B.Sc., II Semester
Paper II -

SECTION – A **26 hrs**

Chemical Energetics	**:**	**13 hrs**
Chemical Equilibrium	**:**	**13 hrs**

1. Chemical Energetics 13 hrs

First law of thermodynamics.Explanation of the terms – internal energy, enthalpy, heat, work, heat capacity.Derivation of expressions for work done in isothermal and adiabatic processes, the relationship between heat capacity at constant pressure and at constant volume.

Important principles and definitions of thermochemistry.Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution.Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data.Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.

Second law of thermodynamics, spontaneous process, explanation of the terms- entropy

Efficiency - Efficiency in terms of heat engine, then Carnot heat engine has to be included

Gibb's free energy, chemical potential. Derivations: dG=VdP-SdT, Gibb's Helmholtz equation

statement of Third Law of thermodynamics, Nernst heat theorem and calculation of absolute entropies of substances.

2. Chemical Equilibrium 5 hrs

Free energy change in a chemical reaction.Thermodynamic derivation of the law of chemical equilibrium.Distinction between ΔG and ΔG^{o}, relationship between standard free energy change and equilibrium constant, Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases.

Ionic Equilibrium 8 hrs

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pK values, pH scale, common ion effect. Salt hydrolysis- all types, calculation of hydrolysis constant.

(Constant Methods for determination of degree of hydrolysis _ from dissociation constants, conductometrric methods, from colligative methods, distribution method

Since the chapter is for 8 hours this can be included)

degree of hydrolysis and pH for different salts. Buffer solutions, Henderson's equations, Solubility and solubility product of sparingly soluble salts – applications of solubility product principle in qualitative analysis.

SECTION –B :Organic Chemistry 26 hrs

Alkyl halides and Aryl halides	:	**9 hrs**
Organometallic compound	:	**4 hrs**
Alcohols, Phenols, Ethers and Epoxides	:	**13 hrs**

Alkyl halides and Aryl halides: 9 hrs

Alkyl halides (Upto 5 Carbons)

Nomenclature, preparation from alkenes and alcohols.Reactions:hydrolysis, nitrite & nitro formation, nitrile &isonitrile formation. Williamson's ether synthesis

Types of Nucleophilic substitution reactions - SN^1,SN^2SNi, mechanisms with energy profile diagrams.Effect of a) Nature of alkyl groups b) Nature of leaving groups c) Nucleophiles and d) solvents on the rate of SN^1 and SN^2 reactions with examples.

Elimination reactions - E_1 and E_2 mechanisms and energy profile diagrams, Saytzeff elimination-mechanism,Eliminationvs substitution.

Aryl halides:

Preparation: Chloro,bromoandiodo-benzene from aniline -Sandmeyer reaction.Aromaticnucleophilic substitution SNAr mechanism,conversion to phenol and effect of nitro substituent. Benzyne mechanism, use of KNH_2/NH_3 or $NaNH_2/NH_3$ as strong bases.

Relative reactivity of alkyl, allyl, vinyl, aryl and aralkyl halides towards nucleophilic substitution.

Organometallic compounds4 hrs

Grignard reagents Preparation: Methyl magnesium iodide (conditions to be discussed). Syntheticapplications: Conversionof methyl magnesium iodide to pri,sec, teralchohols, ethanoic acid, ethanal ,propanone, ethanamine,

Organolithium compounds: preparation of methyllithium. synthetic applications: conversion of methyl lithium to methane andethanoic acid.

Lithiumdialkylcuprates-preparation: Lithium dimethyl cuprate from methyl iodide.

Synthetic applications-preparation of higher alkanes.

Alcohols, Phenols, Ethers and Epoxides 13 hrs

Alcohols: Introduction and classification. Methods of preparation from carbonyl compounds – reduction of aldehydes and ketones (by Meerwin-Pondorf-Verley reaction, reduction of acids and esters using $LiAlH_4$ and from alkenes.Reactions of alcohols-acidic nature, esterification, oxidation with $KMnO_4$,PCC,PDC,Oppaneur oxidation. Comparison of reactivity of pri, sec, and ter-alcohols, Lucas test and using potassium dichromate

Glycols - Preparation from alkenes, Reactions: oxidation with periodic acid with mechanism. Pinacol-Pinacolone rearrangement.

Glycerol- Preparation from propene, Reactions - nitration, action of concentratedsulphuricacid, oxidation with periodic acid and uses.

Phenols

Classification- mono,di and tri hydric phenols with examples

Acidic nature, comparison of acidic strength of alcohol, phenols and monocarboxylic acids.Effect of electron withdrawing group $-NO_2$ and electron donating group $-CH_3$ on acid strength of phenols at o,m,p- positions.

Reactions: Pechmann reaction-uses of coumarins,Reimer Tiemann. Kolbe-Schmidt, Schotten – Baumannreaction.

Industrial applications: Synthesis of aspirin, methyl salicylate, salol.

Ethers and Epoxides

Ethers:

Preparation of diethyl ether -dehydration of ethanol,Williamson's ether synthesis. Reactions: Ethers as Lewis bases (complexation with metal ions), cleavage of ethers - Zeisel's method- significance, auto oxidation.

Epoxides: Preparation -using per acids, Reactions: mono and 1, 2-disubstituted epoxides with a) carbon nucleophiles eg, CH_3MgI,nitrogen nucleophiles, eg NH_3, reduction with $LiAlH_4$.

Reference Books:

1. Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
2. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
3. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
4. Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S. □ Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
5. Bahl, A. &Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010. □ Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
6. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
7. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
8. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998). □ Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York
9. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi(1988).
10. Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S. □ Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson,2010.
11. Bahl, A. &Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010. □ Barrow, G.M.

Physical Chemistry Tata McGraw-Hill(2007).

B.Sc., - III Semester

Paper III -

SECTION – A **26 hrs**

Solutions	:	**6 hrs**
Phase Equilibria	:	**6 hrs**
Conductance	:	**7 hrs**
Electrochemistry	:	**7 hrs**

1. Solutions: 6 hrs

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperaturecomposition curves of ideal and non-ideal solutions. Distillation of solutions.Lever rule.Azeotropes.

Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids.

Immiscibility of liquids- Principle of steam distillation.Nernst distribution law and its applications.

2. Phase Equilibria 6 hrs

Phases, components and degrees of freedom of a system, criteria of phase equilibrium.Gibbs Phase Rule and its (thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibriaDerivation of Clausius – Clapeyron equation and its importance in phase equilibria.)This portion can be shifted to Chemical energetics and its application in Phase rule can be specified)

Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, $FeCl_3$-H_2O and Na-K only).

3. Conductance 7 hrs

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes.Kohlrausch law of independent migration of ions.Transference number and its experimental determination using Hittorf and Moving boundary methods.Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt.

4. Electrochemistry 7 hrs

Reversible and irreversible cells.Concept of EMF of a cell.Measurement of EMF of a cell.Nernst equation and its importance.Types of electrodes.Standard electrode potential.Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data. Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge.pH determination using hydrogen electrode, Calomel, Glass and quinhydrone electrode. Problems.

SECTION –B 26hrs

Aldehydes and Ketones	**:**	**6 hrs**
Carboxylic acids and their derivatives	**:**	**8hrs**
Amines	**:**	**7hrs**
Carbohydrates	**:**	**5hrs**

Aldehydes and Ketones6 hrs

Nomenclature,preparation of aldehydes- Rosenmund reaction,Gattermann-Koch synthesis.Preparation of ketonesfrom nitriles,carboxylic acids with alkyl lithium, acid chlorides with metal alkyls.

Aldol condensation, Perkin condensation, Knoevenagel condensation, benzoin condensation-mechanisms, Mannich reaction.

Condensation with ammonia and its derivatives (NH_2–R, –NH_2, –NHPh, –OH, -CO-NH-NH_2).General mechanism.

Reduction using $LiAlH_4$ and $NaBH_4$, comparison.Wolff-Kishner reduction- example, Clemmensen reduction-mechanism.

Carboxylic acids and their derivatives 8hrs

Carboxylic acids:

Nomenclature,Classification- mono, di, tri carboxylic acids, hydroxy acids -lactic acid, tartaric acid and citric acid. Monocarboxylic acids:preparation - acid hydrolysis of nitriles with mechanism. Acidic strength-pKa values.Effect of substituents on the strength of aliphaticandaromatic carboxylic acids. Comparison of acid strength of formic and acetic acid, acetic acid and monochloro, dichloro, trichloro acetic acids, benzoic and p-nitrobenzoic acid, p-aminobenzoicacid, explanation.

Reactions: Formation of esters, acid chlorides, amides and anhydrides. Hell-Volhard-Zelinsky reaction, decarboxylation and reduction using $LiAlH_4$.

Di and tri carboxylic acids: Action of heat on dicarboxylic acids -oxalic acid, malonic acid, succinic acid, glutaric acid and adipic acid. Reactions of tartaric acid and citric acid -action of heat and reduction with HI.

Acid derivatives

Acid chlorides - hydrolysis, reaction with alcohol, ammonia and lithium dialkylcuprates.Acid anhydrides –acetic anhydride- hydrolysis, reaction with alcohol and ammonia. Amides -hydrolysis, reduction, Hoffmann degradation.

Esters - acid hydrolysis and alkaline hydrolysis, ammonolysis and alcoholysis.

Amines 7hrs

Classification, nomenclature, preparation of alkyl and aryl amines -reductive amination of carbonyl compounds,Gabriel phthalimide synthesis, reduction of nitrobenzene, Hoffmann's bromamide reaction. Relative basicity of amines in aqueous solution, explanation using inductive, resonance, steric and solvation effects.

Reactions- amines as nucleophiles (methylation and acylation), formation of quaternary ammonium salts (reaction of tertiary amine and alkyl halide),distinguishing reactions of 1^{o}, 2^{o} and 3^{o} amines (Reactions with equations for Hinsbergs test).

Diazotization: formation of benzene diazonium chloride. Synthetic applications – conversion to phenol,phenyl hydrazine, aniline, p-hydroxyazobenzene.

Carbohydrates:5hrs

Classification (based on number of monosaccharide units) with examples.Monosaccharides: definition with examples, classification of monosaccharides (based on functional group). Aldoses: Structures of D-aldohexoses. Elucidation of open chain structure of D-glucose. Limitations of open chain structure of glucose. Mechanism of mutarotation and anomeric effect.Elucidation of ring structure and size of D-glucose by oxidation with HIO_4. Ketoses: Structure of fructose-pyranose and furanose forms. Haworth structures. Epimers, Inter-conversion of glucose and fructose.

Disaccharides: Definition and examples. Formation of glycosidic bonds.Haworth and conformational structures of maltose, lactose and sucrose.

Reference Books:

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
4. Mahan, B.H. University Chemistry, 3rd Ed. Narosa (1998).
5. Petrucci, R.H. General Chemistry, 5th Ed., Macmillan Publishing Co.: New York (1985).
6. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
8. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
9. Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed., W. H. Freeman.
10. Berg, J.M., Tymoczko, J.L. &Stryer, L. Biochemistry, W.H. Freeman, 2002
11. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi(1988).
12. Bahl, A. &Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010. □ Barrow, GM. Physical Chemistry Tata McGraw-Hill(2007).

B.Sc., IV SEM
Paper - IV

SECTION –A Inorganic Chemistry 26 hrs

General Principles of Metallurgy	:	**5 hrs**
Transition Elements (3d series)	:	**8 hrs**
Coordination Chemistry & Crystal Field Theory	:	**13hrs**

1. General Principles of Metallurgy

Ellingham's diagram: principle, salient features, Curves corresponding to formation of CO, CO2 and oxides of Cr, Al, Mg, Ca, Hg, & Ag. Applications with reference to selection of reducing agents using Carbon for ZnO and Al for Cr2O3.

Extraction of the following metals i) Nickel from pentlandite ore ii) Thorium from monazite sand iii) Uranium from pitch blende

Powder metallurgy : Advantages of Powder metallurgy and its applications. Methods of production of metal powders.Production of Tungsten powder from Wolframite.

2.Transition Elements (3d series) 8 hrs

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.

Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only).

3. Coordination Chemistry & Crystal Field Theory 13hrs

Coordination Chemistry: Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT.IUPAC system of nomenclature.

Crystal Field Theory: Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry.Factors affecting the magnitude of D. Spectrochemical series.Comparison of CFSE for Oh and Td complexes, Tetragonal distortion of octahedral geometry.Jahn-Teller distortion, Square planar coordination.

SECTION –B

: Physical Chemistry 26 hrs

Kinetic Theory of Gases	:	**10 hrs**
Liquids	:	**3 hrs**
Solids	:	**6 hrs**
Chemical Kinetics	:	**7 hrs**

1. Kinetic Theory of Gases: 10 hrs

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behavior, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation.Andrews isotherms of CO_2.

Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance. Temperature dependence of these distributions.Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

2. Liquids 3 hrs

Surface tension and its determination using stalagmometer.Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

3. Solids 6 hrs

Forms of solids.Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices.X–Ray diffraction by crystals, Bragg's law.Structures of NaCl, KCl and CsCl (qualitative treatment only).Defects in crystals.Glasses and liquid crystals.

4. Chemical Kinetics 7 hrs

The concept of reaction rates.Effect of temperature, pressure,catalyst and other factors on reaction rates.Order and molecularity of a reaction.Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants).Half–life of a reaction.General methods for determination of order of a reaction.Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).problems.

Kinetic study of reactions between hydrogen peroxide and iodide ion in acid medium by and saponification of ethyl acetate by conductometric method

Reference Books:

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
5. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).
6. Cotton, F.A. & Wilkinson, G. Basic Inorganic Chemistry, Wiley.
7. Shriver, D.F. & Atkins, P.W. Inorganic Chemistry, Oxford University Press.
8. Wulfsberg, G. Inorganic Chemistry, Viva Books Pvt. Ltd.
9. Rodgers, G.E. Inorganic & Solid State Chemistry, Cengage Learning India Ltd., 2008

B.Sc., V SEM
Paper - V - Physical Chemistry

SECTION – A **20 hrs**

Optical methods of Analysis	**:**	**16hrs**
Photochemistry	**:**	**4 hrs**

1. Molecular Spectroscopy **16 hrs**

Molecular Spectroscopy: Interaction of electromagnetic radiation with molecules and various types of spectra; Born Oppenheimer approximation.

Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.

Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules.

Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals.

2. Photochemistry 4 hrs

Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.

SECTION –B

: Analytical Methods in Chemistry 20 hrs

Qualitative and quantitative aspects of analysis	:	**3 hrs**
Thermal methods of analysis	:	**3 hrs**
Electroanalytical method	:	**5 hrs**
Separation techniques	:	**9 hrs**

1. Qualitative and quantitative aspects of analysis 3 hrs

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution of indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

2. Thermal methods of analysis 3 hrs

Theory of thermogravimetry (TG), basic principle of instrumentation.Techniques for quantitative estimation of Ca and Mg from their mixture.

3. Electroanalytical method 5 hrs

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

4. Separation techniques. 9hrs

Too much chromatic Technics included, it requires more than 9 hours

Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media.

Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution

and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.

Reference Books:

1. Banwell, C. N. &McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2006).
2. Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001). House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004).
3. Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005).
4. Kakkar, R. Atomic & Molecular Spectroscopy: Concepts & Applications, Cambridge University Press (2015).
5. Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. Vogel's Textbook of Quantitative Chemical Analysis, John Wiley & Sons, 1989. □
6. Willard, H.H., Merritt, L.L., Dean, J. &Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
7. Christian, G.D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
8. Harris, D. C. Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
9. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
10. Skoog, D.A. Holler F.J. &Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed.
11. Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.

B.Sc., - V Semester

PAPER VI - Biochemistry

SECTION – A-Energetics and Gene Regulation **20 hrs**

Introduction to Biochemistry	:	**2 hrs**
Energetics of Biochemical Reactions	:	**4 hrs**
Vitamins	:	**2 hrs**
Enzymes	:	**3 hrs**
Nucleic Acids	:	**3 hrs**
Information Flow in Biological Systems	:	**4 hrs**
Hormones	:	**2 hrs**

1. Introduction to Biochemistry 2 hrs

Contributions of Emil Fischer, Louis Pasteur, Embden, Mayerhof, Parnas, Hans Kreb, Michaelis and Menton, Watson and Crick, Chargaff, H.G. Khorana, Knoop, Pauling and Hopkins.

Elemental and biochemical composition of living organisms.Role of water in biochemical systems (mention the properties dielectric constant, surface tension, heat of vaporization, MP and BP, specific heat).

2. Energetics of Biochemical Reactions 4 hrs

Bioenergetics: Introduction – stages of energy transformation. Exergonic and endergonic reactions.Relationship between ΔG^{o} and K_{eq}. High Energy Phosphates- Definition with examples; ATP, PEP,1,3-diphosphoglycerate, creatinephosphate-structural features that makes them high energy compounds. Redox potentials of some biological important half reactions, Calculation of energy yield from biological redox reaction (Oxidation of NADH and $FADH_2$ by oxygen, reduction of acetaldehyde by NADH). Mitochondrial electron transport chain with brief explanation of P/O ratio and ATP Synthase complex.Oxidative Phosphorylation.Substrate Level Phosphorylation.Definition of anabolism and catabolism with suitable example.

3. Vitamins 2hrs

Introduction and Definition of vitamins, Classification of vitamins based on solubility, Sources, Biological significance and deficiency syndrome of each vitamin.

4. Enzymes 3 hrs

Introduction, Holo enzyme (apo-enzyme and co-enzyme).Active site and specificity, Classification of enzymes with examples.Enzyme substrate interaction-Fischer and Koshland models. Enzyme kinetics- factors affecting rate of enzymatic reactions- enzyme concentration, substrate concentration, pH and temperature, M.M equation with significance. Enzyme Inhibiton-Competitive, non-competitive and uncompetitive, Allosteric inhibition with one example for each.

5. Nucleic Acids 3hrs

Components of nucleic acids- Nitogen bases, sugars.Structure of nucleosides, nucleotides and polynucleotides (DNA and RNA), Biological roles of DNA and RNA.Properties of nucleic acids-with acids and bases, temperature stability of nucleic acids, Nucleic acids as genetic materials.

Protein-nucleic acid interaction- chromatin and viral nuclear capsids.

6. Information Flow in Biological Systems **4 hrs**

Central dogma of Molecular biology, Replication, transcription and translation. Genetic code-general features. Mutation-sickle cell anaemia.

7. Hormones **2 hrs**

Definition.Classification-amino acid derivatives, peptide and polypeptide and Steroid hormones with functions. Tropic hormones (hormones released by adrenals and hypothalamus). Role of Insulin and Glucagon in glucose homeostasis.Feedback regulation, secondary messengers-Ca^{2+}, cyclic AMP.

SECTION –B - Biomolecules of Life **20 hrs**

Carbohydrates	:	**4 hrs**
Carbohydrate Metabolism	:	**3 hrs**
Lipids	:	**4 hrs**
Lipid Metabolism	:	**2 hrs**
Amino Acids and Proteins	:	**5 hrs**
Protein Metabolism	:	**2 hrs**

1. Carbohydrates **4hrs**

Introduction and Classification of carbohydrates with examples. Derivatives of monosaccharides-Amino sugars-Haworth structure and biological importance of β-D-glucosamine, galactosamine and their N-acetylated forms: (NAMA, NANA). Sugar Acids- Haworth structure and biological importance of D-gluconic acid, D-glucuronic acid and D-glucaric acid. Sugar Phosphates- Haworth structure and biological importance of D-Glucose-6-phosphate, D-Fructose-6-phosphate, D-Fructose-1,6-diphosphate, β-D-ribose-5-phosphate and β-D-deoxyribose-5-phosphate. Haworth structure and biological importance of oligosaccharides-Isomaltose, Cellobiose, Trehalose.Polysaccharides-partial structure and biological function of starch, glycogen, cellulose, chitin and inulin.

2. Carbohydrate Metabolism **3hrs**

Glycolysis, fates of pyruvate, TCA cycle, Energetics. Gluconeogenesis –synthesis of glucose from lactate.

3. Lipids **4hrs**

Introduction, Classification- simple, complex and derived with examples.Solubility of lipids. Fatty acids- definition, classification – saturated and unsaturated with examples and structure of lauric, myristic, palmitic, stearic, oleic, linoleic, linolenic and arachidonic acids. Essential fatty acids-definition with examples.

Triglycerides- Structure and properties- acid and alkali hydrolysis, saponification number and its significance, Biological importance of triglycerides.

Phosphoglycerides- General Structure of 3-Sn-phosphatidic acid, lipid bilayer, micelles, liposomes with applications, structure and biological importance of lecithin, cephalin, phosphatidylserine, phosphatidylinositol.

Cholesterol- structure and biological significance

4. Lipid Metabolism 2hrs

Activation of fatty acids, role of carnitine, β-oxidation and energetics.

5. Amino Acids and Proteins 5 hrs

α-amino acids: Introduction, structure, classification on the basis of polarity of R-groups, essential and Non-essential amino acids, zwitter ion, reaction of amino acids with Nihydrin, Peptide Bond. Sanger, Edman's reactions and their significance.

Proteins-brief study of enzyme and muscle proteins, Levels of Organizations of Protein: Primary, secondary, tertiary and quaternary structures with examples (α- helix, β-pleated sheet, triple helix and haemoglobin) Denaturation and renaturation: Aufinsen's experiment, separation of proteins by PAGE.

6. Protein Metabolism2hrs

Transamination, deamination and decarboxylation.Urea Cycle.

Recommended Books/References:

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed., W. H. Freeman.
5. Berg, J. M., Tymoczko, J. L. &Stryer, L. Biochemistry 7th Ed., W. H. Freeman
6. Concise Text Book of Biochemistry T. N. Pattabhiraman, All India Publishers, 2000.
7. Biochemistry A. L. Lehninger. al., CBS, 2000.
8. A Text Book of Biochemistry A. V. S. S. Rama Rao, UBSPD, 1998.
9. Biochemistry P. C. Champe and R. A. Harvey, J. B. Lipincott& Co, 1982.
10. Fundamentals of Biochemistry J. L. Jain, S. Chand & Co., 1983.
11. Biochemistry COSIP-ULP, Bangalore University, 1981.
12. Outlines of Biochemistry Conn E. E and Stumpf P. K., John Wiley & Sons, 1978.
13. General Biochemistry Weil J. H., Wiley Eastern
14. Biochemistry Campbell M. K., Harcourt Brace & Co.
15. Essentials of Biochemistry U Sathyanarayana.
16. Principles of Biochemistry Nelson and Cox.
17. Biochemistry Pawar and Chatwal.

18. Biochemical techniques Upadhyay and Upadhyay

19. Analytical Biochemistry and Biochemical techniques Ashokan P

B.Sc., VI Semester

PAPER VII - Inorganic Chemistry

SECTION – A

: Inorganic materials of industrial importance 20hrs

Fertilizers	:	**4 hrs**
Silicate Industries: Glass Ceramics and Cement	:	**6 hrs**
Surface Coatings (paints)	:	**4hrs**
Chemical explosives	:	**2 hrs**
Alloys	:	**4 hrs**

Fertilizers 4 hrs

Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.

Silicate Industries 6 hrs

Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.

Surface Coatings 4 hrs

Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings.Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing

Chemical explosives 2 hrs

Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX).Introduction to rocket propellants.

Alloys **4 hrs**

Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels.

SECTION- B:

Industrial Chemicals, Environmentand Novel inorganic solids 20 hrs

Nanomaterials	:	**4 hrs**
Synthesis and modification of inorganic solids	:	**2 hrs**
Industrial Gases and Inorganic Chemicals	:	**10 hrs**
Energy and Environment	:	**4 hrs**

Nanomaterials 4 hrs

Overview of nanostructures and nanomaterials: classification. Preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control of nanoarchitecture-one dimensional control.Carbon nanotubes and inorganic nanowires.Bio-inorganic nanomaterials, DNA and nanomaterials, natural and antisicalnanomaterials, bionano composites.

Synthesis and modification of inorganic solids 2 hrs

Conventional heat and beat methods, Co-precipitation method, Sol-gel methods, Hydrothermal method, Ion-exchange and Intercalation methods.

Industrial Gases and Inorganic Chemicals 10 hrs

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

Energy &Environment 4 hrs

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc. Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

Reference Books:

1. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
2. R. M. Felder, R. W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: Introduction to Ceramics, Wiley Publishers, New Delhi.
4. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
5. P. C. Jain & M. Jain: Engineering Chemistry, DhanpatRai& Sons, Delhi.
6. R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.
7. B. K. Sharma: Engineering Chemistry, Goel Publishing House, Meerut
8. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
9. R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers New Delhi.
10. J. A. Kent. Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
11. S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.
12. K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.
13. S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.
14. S.E. Manahan, Environmental Chemistry, CRC Press (2005).
15. G.T. Miller, Environmental Science 11th edition. Brooks/ Cole (2006).

A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).

16. Shriver & Atkins. Inorganic Chemistry, Peter Alkins, Tina Overton, Jonathan Rourke,
17. Mark Weller and Fraser Armstrong, 5th Edition, Oxford University Press (2011-2012)
18. Adam, D.M. Inorganic Solids: An introduction to concepts in solid-state structural chemistry. John Wiley & Sons, 1974.
19. Poole, C.P. & Owens, F.J. Introduction to Nanotechnology John Wiley & Sons, 2003.
20. Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.

PAPER VIII
ORGANIC CHEMISTRY

SECTION-A:

Application of spectroscopy to simple organic compounds	**:**	**10 hrs**
Active Methylene Compounds	**:**	**3 hrs**
Stereo chemistry	**:**	**7 hrs**

Application of spectroscopy to simple organic compounds : 10 hrs

Introduction: electromagnetic spectrum, advantages of spectroscopic techniques, types of spectroscopic techniques (UV-Visible spectroscopy, IR spectroscopy, NMR spectroscopy).

UV-Visible spectroscopy: Introduction – basic principles of UV-Visible spectroscopy. Types of electronic transitions with suitable examples.Chromophores and auxochormes (examples).Blue shift and red shift (with examples). Influence of conjugation on λ_{max} absorption in UV – Visible region. Comparison of UV spectra of acetone and methyl vinyl ketone. Graphical representation of spectra of 1,3-butadiene, benzene and lycopene. Advantages of UV-Visible spectroscopy.

IR spectroscopy: Introduction – Basic principles of IR spectroscopy. Conditions for IR active organic compounds. Vibrational transitions: Stretching and bending modes of vibrations, factors affecting on position of IR absorption peak (atomic mass and force constant-electronic effects and hydrogen bonding). Types of IR region (functional group region and finger print region). Explanation of stretching frequencies of –OH (free and H-bonded), alkyl –C–H, alkenyl C-H, alkynyl C-H,C=C, C=C, C–C, C=O and C–O groups (IR spectra of acetaldehyde, acetone, ethanol, ethylene, benzene, acetylene, acetic acid and phenol).Applications of IR spectroscopy.

NMR spectroscopy: Basic principles of proton magnetic resonance: Nuclear magnetic spin quantum number, influence of the magnetic field on the spin of nuclei, spin population, nuclear magnetic resonance. Chemical shift (δ values), uses of TMS as reference. Nuclear shielding and deshielding effects.Equivalent and non-equivalent protons.Effect of electronegativity of adjacent atoms on chemical shift values.Spin-spin splitting and spin-spin coupling (qualitative treatment only). Graphical representation (interpretation) of NMR spectra of simple organic compounds (i) methane (ii) CH_3–Cl (iii) CH_2Cl_2 and (iv) $CHCl_3$ using shielding and deshielding effects, (iv) Cl_2CHCHO (v) 1,1,2-trichloroethane and (vi) CH_3CH_2Cl using spin-spin splitting and spin-spin coupling.

Active Methylene Compounds 3 hrs

Acidity of α-hydrogen atoms in active methylene compounds. ex-diethylmalonate, ethyl acetoacetate and acetyl acetone.

Diethyl malonate -preparation from acetic acid.Synthetic applications -preparation of monocarboxylic, dicarboxylic, unsaturated acids, ketones, cyclic compounds-barbituric acid.

Ethyl acetoacetate-preparation from ethyl acetate.Synthetic applications of ethyl acetoacetate - preparation of monocarboxylic, dicarboxylic, unsaturated acids, ketones.

Stereo chemistry **7 hrs**

Introduction:optical isomerism, optical activity, dextro and laevo rotatory molecules (d/l, +/–),specific rotation, criteria for optical activityi) Elements of symmetry: plane, center, alternate axis of symmetry–definition, examples

Molecular chirality, enantiomers- absoluteconfiguration D/L notations, R/S notations-Cahn-Ingold-Prelog sequence rules to be explained taking suitable examples, meso compounds, diastereomers and properties. Relative Configuration of threo and erythro isomers.

Racemisation: Definition and mechanism,Resolution of racemic mixture: definition, explanation of resolution of racemic mixture of tartaric acid by chemical method and biochemical method.

Atropisomerism- diphenyl systems.

Geometric isomerism in alkenes: definition, conditions,examples. Determination of configuration of geometric isomers: cis and trans by (i) Physical methods (melting and boiling points, dipole moments, solubility) (ii)Spectroscopic methods (UV, IR evidences) (iii)chemical methods - cyclisation method pKavalues E and Z system of nomenclature -rules with suitable examples.

SECTION-B:

Pharmaceutical chemistry	:	**4hrs**
Polymers	:	**3 hrs**
Terpenes and Alkaloids	:	**7hrs**
Heterocyclic compounds	:	**4 hrs**
Green chemistry	:	**2 hrs**

Pharmaceutical chemistry **4hrs**

Classification of Drugs: analgesics and antipyretics,anti-inflammatory drugs-aspirin, paracetamol, lbuprofen, antibiotics (Chloramphenicol); antibacterial and antifungal Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim, antiviral drugs -Acyclovir, Central Nervous System agents- phenobarbital, diazepam, Cardiovascular-Glyceryltrinitrate, HIV-AIDS drugs (AZT-Zidovudine).

Polymers **3 hrs**

Brief introduction to preparation, structure, properties and application of the following polymers:polyolefins,polystyreneandstyrenecopolymers,polyvinylchloridepolyvinyl acetate, acrylic polymers, fluoro polymers, polyamides. Phenol formaldehyde resins -Bakelite, Novalac, polyurethanes, silicone polymers,polydienes, polycarbonates, Conducting Polymers- properties, preparation of polyacetylene, polyaniline, polypyrrole, polythiophene

Terpenes and Alkaloids: **7hrs**

Terpenes

Occurrence, isoprene rule, special isoprene rule, isolation of essential oils.classification (on the basis of number of isoprene units, acyclic and cyclic)

Citral: elucidation of structure and synthesis from methyl heptenone ,

Zingiberene: preparation from p-methoxymethylmagnesium bromide.

structures of limonene, menthol, α-terpineol, camphor, β-carotene, vitamin-A and their uses.

Alkaloids

Introduction, classification (based on heterocyclic ring present) and general characteristics.Determination of functional nature of nitrogen- Hoffmann's exhaustive methylation method. Nicotine:elucidation of structure and synthesis from succinimde.Structures and uses of ephedrine, caffeine, cocaine, atropine, quinine and morphine.

Heterocyclic compounds **4 hrs**

Introduction, classification (based on size of heterocyclic ring – 5 and 6 membered)

with examples, stability-resonance and aromaticity, molecular orbital structures, resonance and aromaticity of furan, pyrrole, thiophene and pyridine based on Huckel's rules.Preparation: pyrrole from acetylene,furan from furrfural,

thiophene from acetylene, pyridine from acetylene. Electrophilic substitution reactions-nitration of pyrrole, furan and thiophene, reaction with sodamide (Chichibabin reaction).Comparison of basicity of pyrrole, pyridine and piperidine (pK_b).

Fused heterocyclic compounds i)Indole – preparation by Fischer synthesis, nitration of indole.

Green chemistry: **2hrs**

Introduction: Definitions of Green Chemistry. Brief introduction of twelve principles of Green chemistry with examples, special emphasis on atom economy, reducing toxicity, green solvents.Green Chemistry and catalysis.Alternative sources of energy-green energy and sustainability.

Reference Books:

1. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
2. ArunBahl and B. S. Bahl : Advanced Organic Chemistry, S. Chand.
3. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (PearsonEducation).
4. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. John R. Dyer: Applications of Absorption Spectroscopy of Organic Compounds, Prentice Hall.
7. R.M. Silverstein, G.C. Bassler& T.C. Morrill: Spectroscopic Identification of Organic Compounds, John Wiley &Sons.
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Press (1998).
9. Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker (2001).
10. Cann, M.C. &Connely, M.E. Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
11. Ryan, M.A. &Tinnesand, M. Introduction to Green Chemistry, American Chemical Society, Washington (2002).
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13. Lancaster, M. Green Chemistry: An introductory text RSC publishing, 2nd Edition.
14. G.L. Patrick: Introduction to Medicinal Chemistry, Oxford University Press, UK.
15. Hakishan, V.K. Kapoor: Medicinal and Pharmaceutical Chemistry, VallabhPrakashan, Pitampura, New Delhi.
16. William O. Foye, Thomas L., Lemke, David A. William: Principles of Medicinal Chemistry, B.I. Waverly Pvt. Ltd. New Delhi

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B.Sc Syllabus
Chemistry Practical's

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2020-2021

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CHEMISTRY PRACTICALS.

CHEMISTRY PRACTICALS - I

1. Calibration of glass wares: i) Pipette ii) Burette iii) Volumetric flask
2. Estimation of potassium permanganate using standard sodium oxalate solution.
3. Estimation of ferrous ammonium sulphate using standard potassium dichromate solution and diphenyl amine as internal indicator.
4. Estimation of Sodium thiosulphate using standard potassium dichromate solution.
5. Determination of percentage of available chlorine in the given sample of bleaching powder.
6. Determination of percentage of manganese dioxide from pyrolusite ore.
7. Estimation of Chloride by Mohr's method (using potassium chromate as an adsorption indicator).
8. Estimation of ferrous and ferric iron in a given mixture using standard potassium dichromate
9. Estimation of Nitrogen in an ammonium salt using standard oxalic acid solution.
10. Estimation of Carbonate and bicarbonate in a given mixture.
11. Estimation of potassium permanganate using standard ferrous ammonium sulphate solution and calculation of water of crystallization.
12. Estimation of copper by iodimetric method.
13. Estimation of sodium hydroxide using standard potassium hydrogen phthalate

CHEMISTRY PRACTICALS – II

1. Purification of compounds – recrystallization and distillation
2. Criteria of purity - determination of melting point and boiling point.
3. Preparation of 7-hydroxy-4-methyl coumarin from resorcinol.
4. Preparation of dibenzal acetone from benzaldehyde.
5. Nitration - Preparation of m-nitrobenzoic acid from benzoic acid.
6. Nitration - Preparation of meta-dinitro benzene from nitro benzene.
7. Preparation of Nerolin or beta-Naphthyl methyl ether from beta-naphthol.
8. Preparation of 2,4-dinitrophenyl hydrazone derivative of benzaldeyde.
9. Acetylation - Preparation of acetanilide from aniline.
10. Bromination - Preparation of tribromophenol from phenol.

CHEMISTRY PRACTICAL – III

Semi-micro qualitative analysis of a salt mixture – not more than four ionic species.

(Two anions and two cations excluding insoluble salts) out of the following:

Cations: NH_4^+, Pb^{2+}, Ag^+ , Bi^{3+}, Cu^{2+},Cd^{2+}, Sn^{2+}, Al^{3+}, Fe^{3+}, Co^{2+}, Cr^{3+},

Ni^{2+}, Zn^{2+}, Mn^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, K^+

Anions: CO_3^{2-}, S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, NO_2^-, CH_3COO^-, Cl^-,Br^-, I^-, NO_3^-, BO_3^{3-}, SO_4^{2-}, PO_4^{3-},

CHEMISTRY PRACTICAL - IV

1. Determination of the density using specific gravity bottle and viscosity of a liquid/dilute solution using Ostwald's viscometer.
2. Determination of percentage composition of a binary liquid mixture by viscosity method/Study of variation of viscosity of an aqueous solution with concentration of a solute.
3. Determination of molar mass of a polymer by viscosity method.
4. Determination of the density using specific gravity bottle and surface tension of a liquid/dilute solution using stalagmometer.
5. Determination of transition temperature of a salt hydrate by thermometric method.
6. To determine the concentration of a given solution by measuring surface tension of solution/Study of variation of surface tension of a detergent solution with concentration.
7. Determination of velocity constant for acid hydrolysis of methyl acetate.
8. Determination of velocity constant for the saponification of ethyl acetate.(a= b)
9. Study of kinetics of iodide-persulphate reaction.
10. Comparison of the strengths of HCl and H_2SO_4 by studying kinetics of acid hydrolysis
11. Determination of distribution coefficient of benzoic acid between water and toluene. or Iodine between water and carbon tetrachloride

CHEMISTRY PRACTICAL - V (PHYSICAL CHEMISTRY)

1. To construct the phase diagram of a two component system (Ex. Diphenyl amine-benzophenone) by cooling curve method.
2. Determination of pK_a of a weak acid by pH metric method.
3. Determination of cell constant and molar conductance at infinite dilution.
4. Conductometric titrations: (i) Strong acid - strong base
   (ii) Weak acid - strong base.
5. Determination of degree of dissociation of a weak acid and dissociation constant by conductance measurements.

6. Estimation of Cu^{2+} colorimetrically and verification of Beer-Lambert's law.
7. Potentiometric titrations: (i) Strong acid – strong base
   (ii) Potassium dichromate – Mohr's salt.

8. Determination of percentage composition of sodium chloride solution by miscibility temperature measurements of phenol-water system. (Study of effect of impurities on it)

CHEMISTRY PRACTICAL - VI (BIOCHEMISTRY)

1. Determination of Saponification number of Fats
2. Estimation of α-amino acids using Ninhydrin by colorimetric method.
3. Separation of α-amino acids by paper chromatography
4. Determination of activity of salivary amylase.
5. Preparation of buffers and determination of pH values of fruit juices using pH meter.
6. Isolation of DNA from Onion peel or Cauliflower.
7. Estimation of ascorbic acid in lemon juice or green chillies.
8. Estimation of reducing sugar by dinitrosalicylicacid (DNS) method.
9. Estimation of Inorganic phosphate by modified Fiske-Subbarow Method.
10. Estimation of creatinine in urine by Jaffe's Method.

CHEMISTRY PRACTICAL - VII (INORGANIC CHEMISTRY)

1. Preparation of complexes: (i) tetraamminecopper(II)sulphate (ii) potassium trioxalatoferrate(III) – determination of their conductance and comparison with simple salts like $MgCl_2$, $AlCl_3$,..
2. Determination of the composition of Fe^{3+}-salicylic acid complex by Job's method
3. Gravimetric Estimation of Barium as Barium sulphate.
4. Estimation of Zn^{2+} using EDTA.
5. Estimation of Mg^{2+} using EDTA.
6. Estimation of Ni^{2+} using EDTA.
7. Determination of total hardness of water using EDTA
8. Estimation of percentage of iron in haematite ore.
9. Determination of calcium in the given sample of Lime stone
10. Gravimetric estimation of nickel as Nickel dimethyl glyoximate.
11. Chromatographic separation of Al^{3+}, Fe^{3+}, Cr^{3+} and calculation of R_f values.

CHEMISTRY PRACTICAL - VIII (ORGANIC CHEMISTRY)

Systematic qualitative analysis of organic compounds possessing following functional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines and esters) and preparation of one solid derivative

Reference Books:

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- Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA,1988..
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- Sawhney, S.K., Randhir Singh. Introductory Practical Biochemistry, 2000, Narosa publisher
- Geetha Damodaran K., Practical Biochemistry, 2nd edition, 2016, Jaypee Brothers Medical Publishers
- Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.